CONFIDENTIAL

CBM
998.205
998.215

Post Office Box 6788
Fort Davis Station
Washington, D. C. 20020

REGISTERED

25X1

[redacted]

Gentlemen:

Subject to your acceptance in the space provided below, the captioned Contract is hereby amended pursuant to Article One (d) of Sections C and E to incorporate therein final overhead rates for the periods specified below:

25X1

[redacted]

Declass Review by NGA.

25X1

[redacted]

Approval of the foregoing rates is subject to the provisions of this Contract and any Task Orders issued hereunder which limit, to the amount of a stated estimated cost, the obligation of the Government to reimburse the Contractor for costs incurred.

Please indicate your acceptance by executing and returning the original and one copy of this Amendment. Retain the third copy for your files.

Very truly yours,

[redacted] 25X1

Contracting Officer

BY_____
Duly Authorized Representative

ACKNOWLEDGED AND ACCEPTED:
THIS ___ DAY OF _____ 1968

25X1 [redacted]

BY_____

TITLE_____

Copy 9

TABLE OF CONTENTS

MAY 20 1965

Approved For Release 2004/11/30 : CIA-RDP78B04770A000300050001-4

1. Introduction

This document serves as a clarification of [redacted] Proposal No. 915908-B: "A Study and Experimental Investigation of Electrophotographic Techniques." Together, these two documents describe a program to increase (photographic) image perceptibility. The proposed efforts include elements of [redacted] Proposal No. 64034-B: "Development of a Modulated-Light Film Viewing Table and Further Study of Modulated-Light Film Viewing Systems." 25X1 25X1

The prototype modulated-light film viewing table is not included in this program, because [redacted] understands that the proposal for its development is being evaluated separately. Certain other elements of proposal No. 64034-B are omitted because of funding limitations. 25X1

Section 2 discusses briefly the nature of the program and its relationship with the long range objectives.

Section 3 is a consolidated statement of the work.

Section 4 is a description of the experimental procedure to implement the work statement of the electrophotographic techniques program.

Section 5 contains some supplementary information concerning the utility of the proposed electronic approach to photographic image modification.

2. Definition of Program Elements

Based upon its understanding of the subject, the [redacted] 25X1

25X1 [redacted] believes that a comprehensive program to improve (photographic) image perceptibility might consist of:

1) An investigation of information transfer processes.

2) An investigation of pertinent image properties.

3) Experimental modification of properties.

4) Evaluation of results.

25X1 [redacted] proposed program concentrates on steps 3 and 4. The comprehensive program would begin with an investigation of information transfer processes affecting image perceptibility. This study, necessarily theoretical and subjective in approach, should increase knowledge of the processes involved in the transfer of information from an image to a human viewer. The next step would be an analytical investigation of those properties and characteristics (of the entire imaging system) which--as a result of the first step--seem to affect image perceptibility. The subjects of this study would include, for example, image sharpness, contrast, and modulation transfer function.

The third step of a comprehensive program would be concerned with the application of results of steps 1 and 2. Experimental modification of pertinent properties of the imaging system (including the photographic record and viewing equipment) should lead to improved image perceptibility. The final step should provide for evaluation of the experimental results.

25X1 [redacted] has already performed valuable parts of the overall effort. Under Government sponsorship, members of the Division recently completed a study of modulated-light film viewing systems. A Company-sponsored investigation of electrophotographic techniques has yielded improved

Ranger, Nimbus, TIROS, and lunar photographs. Both programs, in a purposely limited sense, have demonstrated the feasibility of techniques for improving image perceptibility.

The two programs led directly to [redacted] Proposal No. 6403h-B: "Development of a Modulated-Light Film Viewing Table and Further Study of Modulated-Light Film Viewing Systems," 23 December 1964 (subsequently modified by [redacted] Proposal No. 915031-A); and [redacted] Proposal No. 915908-B: "A Study and Experimental Investigation of Electrophotographic Techniques," 24 March 1965 (essentially modified herein). Most of the previously proposed efforts are now incorporated into a single program of proposed study and development of techniques and equipment to improve image perceptibility. 25X1 25X1

This new program again forms only a part of the comprehensive program discussed above. Limited resources prevent [redacted] from proposing full investigations of all pertinent information transfer processes and image properties. The suggested experimental efforts are limited to modification of only some system properties; these are discussed below. It should be stated here that the Division considers this to be a preferred approach to the subject. In brief, photographic "de-blurring" has been achieved for certain photographs with limited equipment in a many-step procedure. Further demonstration of the electrophotographic techniques (utilizing improved equipment) is indicated. The inherent advantages of an electronic approach (e.g., rapid processing) point to "breadboard" development of electronic equipment. The results of this project can then be evaluated in terms of image perceptibility. This should lead to a better understanding of the processes and properties involved. 25X1

Given a photographic record (i.e., a negative or transparency), modification of image (system) properties may occur during replication or viewing. That is, the image may be processed before it is viewed, or while it is being viewed, or both. Contact or magnified versions of the

image may be employed, separately or in cascade, during replication or viewing. (Rear-projection viewers are examples of magnifying viewers.)

25X1 [redacted] Proposal No. 64034-B (with its amendment, [redacted] Proposal No. 915031-A) applies to image modification during viewing. The proposed efforts include: construction of a prototype modulated-light film viewer (contact viewer), study and development of modulated-light projection viewers (magnifying viewer), and study and development of a small-area (absolute) contrast-stretch system (also contact viewing). 25X1

25X1 [redacted] Proposal No. 915908-B applies to image modification during replication. The proposed efforts include: further study and development of electrophotographic "de-blurring" techniques (contact or magnified processing), and study and development of electronic techniques and equipment to achieve enhanced high-frequency contrast, etc. in real or near-real time (also contact or magnified processing). In addition, this latter proposal included development of a frequency analyzer.

In the light of detailed Government [redacted] discussions and considerations, 25X1 a clarified program objective and work statement are presented below. This single program, which incorporates most of the above tasks in a necessarily limited effort to improve image perceptibility, should yield useful results, among which are:

1) demonstrations of effectiveness of "de-blurring" for a wider range of pictures than has presently been demonstrated.
2) demonstrations of the feasibility of providing the facility of "de-blurring" techniques in a matter of seconds - and thus of great use to operational photo interpreters.
3) demonstrations of feasibility of other (as yet to be discovered) techniques of improving perceptibility.

3. Statement of Proposed Work

The objective of the program will be the improvement of the perceptibility of images. This field of endeavor is very broad and can include work in optics, photography, electronics, physiology, psychology, and other related disciplines. To attempt an attack on the problems from all fronts simultaneously would too severely dilute a limited initial effort. Consequently [redacted] proposes the following program of initial experimentation and development, which is within the capabilities of the personnel and facilities available for the program. The tasks to be performed are those which [redacted] feels will be of benefit to the customer by providing useful knowledge, useful equipment, and a sound experimental program for acquiring of data to refine the underlying theories. The results obtained will lead to useful expansions or extensions of the work in the future.

25X1

25X1

It should be noted that a proposal has been submitted for development of a prototype modulated-light film-viewing table. This equipment is within the field of improvement of image perceptibility, but the proposal for its development is to be considered separately from this proposal.

The present proposal comprises a program of work in the following areas:

A. Modification of photographic images.

(1) by electro-photographic techniques

(2) by electronic techniques

B. Modified viewing of images with modulated-light rear-projection viewer.

C. Image spatial frequency analyzer.

A(1) The electrophotographic techniques study will be principally an experimental effort, based on the techniques developed at [redacted] and applied to moon photographs and others, to determine the effectiveness of these and similar techniques when applied to photographic samples to be supplied by the customer.

25X1

It is expected that the customer will participate throughout the program by comparative evaluation of processed and original photographs. In this manner those techniques which have utility to the customer can be pursued. Some of the specific objectives of the proposed investigation will be as follows:

(1) Investigation of density/transmittance requirements as a function of subject-matter content and image size.

(2) Partial suppression of densities around image elements for increase of image fidelity.

(3) Maintenance of continuous tonal contrast to the extent that, when image magnification is used, graininess is not apparent to the observer.

(4) Comparison of the original and final images in terms of the observer's eye response and the measured values obtained.

(5) Determination of fidelity-ratio response and fidelity-defect factor between the original and final transparencies for several types of shape and image structures. These will be used to evaluate image correction.

The proposed investigation would comprise the following seven tasks:

Task I - Material and Equipment Procurement and Equipment Setup

This task involves the obtaining of materials and hardware necessary to the evaluation, the establishment of standards for the evaluation setup, and the calibration of the equipment.

Task II - Evaluation of Customer-Supplied Transparencies for Qualification Measurements

This task comprises an analysis of the original transparencies in terms of:

(a) Density distribution

(b) Shape and structure of images

(c) Linear resolving power

(d) Spacing of details

Task III - Evaluation of Film Types for Positive/Negative Correlation

This task involves the following individual efforts:

(a) Processing and evaluation of film types

(b) Grouping of film types in accordance with applications

(c) Preliminary experimental application

(d) Establishing density-relationship controls

(e) Experimental sampling of eye response to established density-relationship controls

(f) Preliminary correlation of eye response with density distribution in transparencies and with transmitted-light distribution

Task IV - Test and Debugging of Intensity-Modulated Light Source

Task V - Experimental Application of Electrophotographic Techniques

Task VI - Analysis and Evaluation of Results

Task VII - Documentation

A(2) The objective of the electronic techniques program will be to use the flexibility of electronic signal processing in combination with the high resolution capability of photographic copying to provide high resolution photographic images modified so as to increase image perceptibility. A further goal is the automation of the process so as to provide, eventually, high speed, high capacity equipment.

The initial tasks to be undertaken are as follows:

(1) The characteristics of electronic signal filters, limiters, thresholders, and amplifiers will be investigated and reviewed in terms of the processing system requirements.

25X1

(2) [redacted] will design and build a feasibility demonstration model incorporating the electrophotographic techniques.

(3) Operation at spatial frequencies greater than 200 cycles/mm will be the goal.

(4) Problems of raster registration will be studied and the best practical limits will be sought.

(5) Evaluation will be made of the effects of variation of high-frequency passband, threshold level, and pulse shape on the subjective appearance of various types of images including those supplied by the customer.

B. Modulated-light rear-projection viewer

25X1

[redacted] will make feasibility studies of the application of modulated-light techniques to rear projection viewers. The results will be reported, and if warranted, recommendations for equipment development will be made.

C. Spatial Frequency Analyzer

The objective is to develop equipment which will permit rapid analysis of the spatial frequencies present in photographs. Because of similarity of some of the equipment required for this effort to that required for A(2) above, the following is predicated upon this work being conducted in addition to that of A(2).

(1) The breadboard equipment described in Section III will be modified to permit experimental demonstration of the spatial frequency analyzer.

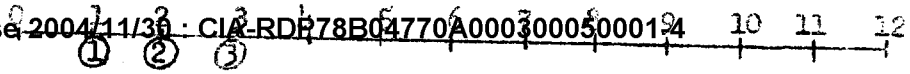
(2) Circuitry to permit automatic compensation for the modulation transfer function of the analyzing spot will be investigated and incorporated, if found to be tractable.

(3) Spatial frequency response greater than 500 cycles/mm will be the goal. It is expected that this goal will be met.

(4) Limited studies of the "frequency signature" mode of operation will be conducted if requested by the customer.

(5) Recommendations for equipment development will be furnished, if the above experiments show that the techniques developed have practical value.

PROGRAM SCHEDULE



Electrophotographic Techniques

Task I

Task II

Task III

Task IV

Task V

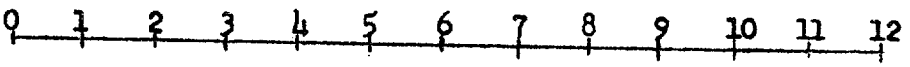
Task VI

Task VII

Note 1: Expected delivery of dryer, film, combination sink, and micro photometer.

2: Expected delivery of micro densitometer and contact printer.

3: Expected delivery of micro copy camera and CRT.



Electronic Techniques

Mod. light source construction

Rear-proj.-viewer study

System study

Specification and ordering of components

Design and construction of breadboard

Evaluation and modification

Frequency Analyzer

Design of Modifications to breadboard

Construction and test of integrations, etc.

Installation and evaluation

Monthly reports

Interim reports

Final report

Experimental Program in Electrophotographic Technique Development

The basic hypothesis is that an item in an image is preceivable when:

(1) Both the background's and the object's brightnesses are within the range of sensitivity of the viewing instrument.

(2) The brightness of the object is sufficiently different from that of the local background as to be distinguishable by the viewing instrument.

(3) The change in brightness (in spatial dimension) from background to object is sufficiently abrupt as to define an "edge".

(4) The extent (spatial dimension) of the object is angularly resolvable by the viewing instrument.

On this basis, then, the general description of the experiment's program can be said to be

A) Select appropriate numerical values so as to make the qualitative hypothesis above, quantitative,

B) Test the hypothesis in specific cases by:

1) Visually examining a photo to be de-blurred to locate an indistinct object representative of the size of objects of interest.

2) Make quantitative measurements in the local neighborhood of this object to determine its apparent size and brightness and sharpness as well as the brightness and the variation of the background.

3) Modify the densities in this local area so as to satisfy the quantitative limits of the hypothesis.

4) Subjectively test for improvement in perceptibility by a photointerpreter.

As in most experimental programs, the work necessary to take care of peripheral problems is much more than that addressed to the problem of interest. It is the same in this case.

We must calibrate the viewing sensor. In this case we will restrict ourselves to considering only the combination of the standard light box and the human eye. This will be calibrated by: the use of test gratings at several O.T.C. steps (object target contrast). This will serve to determine contrast perception at several brightness levels. The subject matter of some of the gratings will be cubes, spheres, and cones as well as squares, discs, and triangles at several contrast and brightness levels.

Another area that will require a great deal of attention is that of the choice of film to be used in making the modified photo. Since the film characteristics of interest here are not always supplied by the manufacturers, candidate types of film will be examined by:

1) Density range and the number of density steps. This is essential for the use of thresholding and cascading effects.
2) The measure of granularity gives resolution at three O.T.C. (object target contrast) levels.
3) The effect on density range and number of density steps by changing the gamma (chemical) and by changing the light intensity while keeping the exposure time increment constant.

Having considered the peripheral problems we can address the main problem. Here again there are complications. The "acutance" is commonly used as a measure of "sharpness". However there is an interaction between this and the granularity of the film. Measurements of both will be made in order to establish, within the limits of our interest, an emperical relationship.

In addition there will be measurements made of:

1) Density for the purpose of defining the original acutance level over most of the original film,
2) Resolution so as to determine whether the limits are defined by the type of film used or by the method of photography,
3) Photometric measurements on the light box so as to determine brightness relationships prior to modification,
4) Isodensitometric traces around specific subject matter which are at or near the threshold level of observation,

will be made on the original photograph.

Since it is suspected that there will be relationships between measures, they will be systematically recorded (together with other data of the original photo, such as format size, general tone, and subject matter). These data will normally be examined by eye, so to speak, in order to identify trends. Whenever a trend is suspected, the data will then be subjected to more critical (though fundamental) statistical analyses.

Having examined the measures made of the original photo, the changes as required to satisfy the hypothesis will be determined.

The changes will then be implemented by choosing the appropriate film and programming the modulated light source. The modified picture will then be measured as before to determine the extent to which the desired changes were realized.

Then the modified picture will be examined by light box and eyes to determine the appropriateness of the change.

V. Additional Information on Electronic Techniques

The following is supplementary information about the proposed processes in the electronic approach to modification of photographic images. The principal purposes are twofold.

1) Reduce low frequency contrast, thereby producing a relative increase of the high frequency components.

2) Absolute increase of contrast in the high frequency components.

That these effects will occur may be seen with the aid of Figures 1 and 2, which show the effects of application of, respectively, negative low spatial frequency, and positive high spatial frequency modulated illumination during the process of replication of a photographic image. The two processes may be made to occur simultaneously if desired, by addition of the proper electronic signals which form the input to the light modulator.

Modulated-light copiers are available from several manufacturers which are unsuitable for high resolution copying, and do not permit modification of the high spatial frequency elements of aerial photographic images. 25X1 [redacted] believes that the proposed system, which uses contact printing with a very small spot light source; will have the capability for high resolution reproduction, and modulation at high, as well as low spatial frequencies. The multiple light sources proposed, which permit open-loop operation, will permit absolute contrast enhancement under stable conditions, which the existing equipment cannot provide. It is expected that the proposed feasibility breadboard equipment will serve as a basis for high quality, high volume, automatic dodging printers, and also for more specialized image modification equipment.

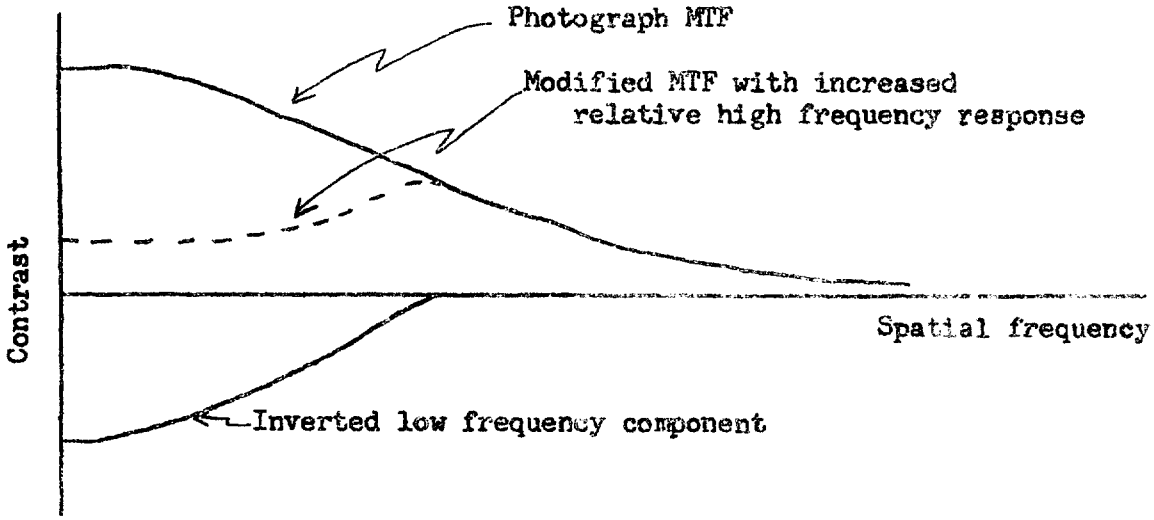


Figure 1.

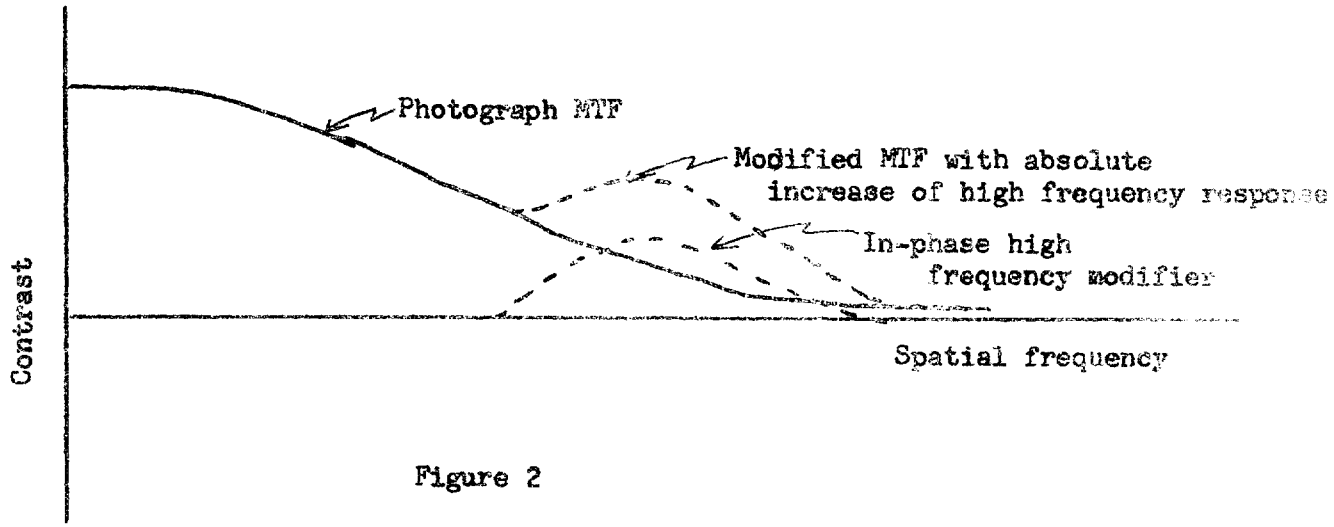


Figure 2

Next 28 Page(s) In Document Exempt

Approved For Release 2004/11/30 : CIA-RDP78B04770A000300050001-4